JOINT ENERGY AND ENVIRONMENT PROJECTS (JEEP)

STOVE CONSTRUCTION TRAINING MANUAL

FOR

TRAINING OF TRAINERS

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CONSTRUCTION MANUAL FOR THE FIREWOOD ENERGY SAVING LORENA ROCKET STOVES

Introduction

Uganda faces a biomass energy crisis marked by an increasing imbalance between the supply and the demand for firewood by households, institutions and industries. One of the most effective strategies to sustainably contribute towards reduction of this problem is through extensive dissemination of biomass energy efficient technologies.

The improved biomass energy efficient technologies have been developed to improve energy efficiency for household, institutional and industrial practices. These include; the domestic firewood stove, institutional firewood stoves and the firewood baking oven.

The improved household shielded lorena rocket stoves have efficiencies of 30 % (average) compared to the traditional (open) 3-stone fire stove at 15.6 %, in a laboratory high power water-boiling test.

These improved stoves help the users to have firewood savings of 50 – 60 % compared to the traditional (open) 3-stone stove.

This implies that the amount of firewood used by a family in one day with a traditional 3-stone fire can be used for 2– 3 days with the shielded or lorena rocket stove. Yet another benefit of these stoves is that they reduce kitchen smoke hence minimizing the effects of indoor air pollution.

Furthermore the socio-economic advantages of the stoves are; they are cheap and built using local materials including clay and anthill soil for the body whereas insulating materials include grass or sawdust or dry banana leaves.

The main objective in developing these improved firewood stoves is to achieve relatively efficient firewood combustion and maximizing heat transfer to the food being cooked.
The purpose of this manual is to provide a practical tool to use in the construction of improved firewood stoves to all interested parties i.e. the shielded rocket fire stoves.

**Basic Facts about the Improved Household Shielded or lorena rocket Firewood Stoves**

The improved household firewood stoves are able to achieve maximum transfer of heat to the food because they heat at least 90% of the saucepan’s surface area and have insulation around the combustion chamber and the fire passages to minimize heat losses.

**Advantages of improved firewood stoves over a 3 stone fire place**

1. Save firewood 2 times than a 3 stone fire place stove
2. Cook faster since the fire is confined in the stove
3. less smoke is produced
4. Easy to use since it has an air in let therefore no need to blow at the flames to keep the fire burning as it is with a three – stone fire.
5. Safe to use
6. Affordable since locally available materials are used.
7. It retains heat
PREPARATIONS BEFORE BUILDING IMPROVED HOUSEHOLD SHIELDED OR LORENA STOVE

1.0 Shelter

The stove must be built in the kitchen to protect it from extreme weather conditions i.e. rain

2.0 Moulds

The metallic mould which is placed at the center of the stove to form the combustion chamber. Its diameter is 9 cm and height 30 cm
Table 1: Tools required for construction of improved energy saving firewood stoves

<table>
<thead>
<tr>
<th>Tool</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Hoe</td>
<td>Digging foundation base and mixing ingredients</td>
</tr>
<tr>
<td>2. Shovel or Spade</td>
<td>Mixing ingredients</td>
</tr>
<tr>
<td>3. Jerrycan</td>
<td>Fetching and keeping water at stand by</td>
</tr>
<tr>
<td>4. Trowel/blunt machete</td>
<td>Smoothing plaster/stove finish</td>
</tr>
<tr>
<td>5. Panga</td>
<td>Cutting and sizing grass, banana stems and stove body</td>
</tr>
<tr>
<td>6. Wheel barrow or Basin</td>
<td>Carrying construction materials to stove construction place</td>
</tr>
<tr>
<td>7. Basin</td>
<td>Measuring materials</td>
</tr>
<tr>
<td>8. Moulds</td>
<td>For creating the combustion chamber, firewood inlet and air in let</td>
</tr>
</tbody>
</table>

3.0 STOVE CONSTRUCTION MATERIALS

Table 2. Materials used in stove construction and their alternatives

<table>
<thead>
<tr>
<th>Materials</th>
<th>Options</th>
<th>Quantity Shielded stove</th>
<th>Quantity Rocket Lorena stove</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Anthill soil</td>
<td>4-6 wheel barrows Or 8-15 basins</td>
<td>8 -12 wheel barrows Or 25 -30 basins</td>
<td></td>
</tr>
<tr>
<td>2 Dry Chopped grass dry chopped banana leaves</td>
<td>2-3 wheel barrows Or 4-8 basins</td>
<td>4 -6 wheel barrows Or 12- 15 basins</td>
<td></td>
</tr>
<tr>
<td>3 Water</td>
<td>4 jerry cans (20 litres each)</td>
<td>7- 10 jerrycans</td>
<td></td>
</tr>
<tr>
<td>4 Metal moulds</td>
<td>3 pieces</td>
<td>3 pieces</td>
<td></td>
</tr>
</tbody>
</table>
4.0 COLLECTION AND DELIVERY OF MATERIALS
Buy or collect all the construction materials and deliver them outside the kitchen for easy mixing and molding.

5.0 MAPPING OUT THE STOVE POSITION IN THE KITCHEN
Choose a right corner in the kitchen to be occupied by the stove. This will be useful in minimizing direct intake of cold air.

Note
It is advisable that the stove’s firewood inlet should not be positioned directly into the kitchen doorway. This helps to minimize direct intake of cold air.

Positioning of the stove in kitchen space

6.0 MATERIAL PREPARATION
Prepare construction materials, at least two days before the time for stove construction. The preparation procedure will depend on the materials combination chosen as described below:
6.1 Dry grass / banana leaves
6.1.1 Use a panga to chop the dry grass into small pieces of approximate length 1cm. This should be done carefully to avoid injuries.

6.2 Anthill soil
Crash the anthill soil into smaller granules, and sort it to eliminate stones, sticks and other unwanted materials.
6.3 Mix the chopped dry grass and anthill soil in a volumetric ratio 1:2 i.e. 1 wheelbarrow of chopped grass : 2 wheelbarrows of anthill soil
6.4 Slowly add water to the mixture to make it moldable.
6.5 Blend the mixture using feet similar to the way the local mud bricks are prepared.
HOW THE SHIELDED FIRE ROCKET STOVE WORKS
Below is the section view of the stove showing how it is intended to function. The saucepan cavity for the shielded fire rocket stove should be deep enough to allow the saucepan to be submerged into the stove cavity. This increases heat transfer to the saucepan.
HOW TO BUILD THE SHIELDED FIRE ROCKET STOVE

The size of the stove will depend on the size of the saucepan to be used in cooking.

Example:
For a home that frequently uses a saucepan of capacity 3.5 litters with a diameter of 26 cm, the size of the combustion chamber will be 13.5 cm.
The saucepan should be positioned directly above the combustion chambe

Wet and mark out position to be occupied by the stove.
7.1 Using the mixture in 6.5 above lay down a 4 cm high base for the stove, bordered by the marked out line.

- While setting the foundation, combustion chamber base should be centered. E.g. The metallic mould is vertically inserted on to the foundation as shown below
The moulds for firewood inlet and air inlet are connected to the combustion chamber mould to form a right angle (90) angle at the base as shown below.

7.4 **Constructing the stove body**

Note: Ensure that the metal moulds remain in their original position.
Continue constructing the stove body using the soil–grass mixture up to the height of the vertical metal mould top.

7.5 Constructing the saucepan cavity
Place a saucepan just at the top of the vertical metal mould (combustion chamber) then place a brick or stones in the saucepan to hold it in position as shown.

• Fill the space around the saucepan with the insulation mixture as shown up to the height of the saucepan rim.

• Remove the saucepan carefully by rotating back and forth while lifting it out.
• Cut out a 2 cm thickness of the mixture layer off the saucepan cavity to enlarge it and give room for the fire (blue gas) to flow around the saucepan cavity during stove use in future.

• Inside the saucepan seat, build 3 saucepan supports equidistant from the centre of the combustion chamber with a uniform angular spacing of 120 degrees.

• These will hold the saucepan high enough to allow the fire (hot flue gases) to flow from the bottom to the sides of the saucepan during stove use in future.

HOW TO BUILD A HOUSEHOLD ROCKET LORENA STOVE
HOW THE ROCKET LORENA STOVE WORKS
Below is the sectioned front view of the rocket lorena stove, showing how it is intended to function. The saucepan cavity is deep enough to submerge the saucepans into the fire (hot gases). This increases the surface area of the saucepan in contact with the fire (hot gases) hence improving heat transfer into the saucepan. This stove uses the rocket elbow combustion chamber with a side inlet for air which improves the air - fuel ratio and combustion efficiency, resulting into an almost smokeless operation. Thermal insulation is obtained by mixing of grass in the stove construction materials using appropriate ratios. During stove use the grass burns out and it creates air pockets which give the stove body a thermal insulative characteristic
7.0 Building the Rocket - Lorena Stove
The size of the stove, combustion chamber and chimney will depend on the size of the big saucepan that will be used when cooking with it. This relationship is based on saucepan dimensions commonly used in Uganda. Example:
For a home that frequently uses two saucepans with diameter 26 cm and 23 cm respectively, the bigger saucepan should be positioned directly above the combustion chamber while the smaller one takes the other position. The size of the combustion chamber will be circular diameter = 13 cm. The inner diameter of the chimney will also be 13 cm.
STOVE CONSTRUCTION

7.1 Wet the marked out position to be occupied by the stove. Using the mixture in 6.1.5 above, lay down should be 4 cm high base for the stove, bordered by the marked out line.
7.2 While setting the foundation, the combustion chamber base should be catered. E.g. if the bigger saucepan with diameter of 26 cm, use 13 cm the diameter of the combustion chamber mould. Vertically insert the combustion mould.

Draw the outline of the stove foundation illustrated in the diagram.

The bigger saucepan should be positioned directly above the combustion chamber while the smaller one takes the other position. In the event that a measuring tape is not available, use your palm width. The width of your palm approximates 10 cm. For the 15 cm measurement use 1½ palm widths.
Bigger saucepan (diameter = 26 cm)
Chimney diameter = 13 cm
Smaller saucepan (diameter = 23 cm)

7.3 Building the combustion chamber

The moulds for firewood inlet and air inlet are connected to the combustion chamber mould to form a right angle (90) angle at the base as shown below
Note: Ensure that mould pieces remain in their original position

7.4 Continue constructing the stove body up to the level at which the vertical mould just gets covered

- Measure out the positions of the saucepans, the chimney and the 10 cm gaps between them.
- Position the big saucepan such that the centre of its bottom sits at the centre of the vertical metallic mould.
- The bigger saucepan, smaller saucepan and chimney must be on the same level
- Then put the smaller saucepan in the other position (as shown)
- Place horizontal banana stem segments each of length 10 cm between the saucepans and the chimney position.
- **Note:** The diameter of all the banana stems should also be equal to the one used for the combustion chamber i.e. 13 cm.
After all the saucepan body is covered by the mud, remove the saucepans carefully by rotating back and forth while lifting.
7.5 Constructing the saucepan cavities

- Place bricks in the saucepans to hold them in position, as shown and fill the space around the saucepans with the insulation mixture. In case bricks are not available, you may use stones of equivalent size.

7.6 Constructing and shaping the Chimney

- Determine a suitable height on the vertical stem for bending the chimney. A height of 75 cm – 100 cm is recommended (depending on the height of the kitchen roof).
- Make a hole in the wall and direct the banana stem through.

7.7 Shaping the Saucepan Cavities

This should be done after 5 - 7 days of drying.

- Using a measuring tape, measure off 2.5 cm of the saucepan cavity. Then using a spoon, scoop out a material thickness of 2.5 cm to create the saucepan ring.
• If you do not have a measuring tape, use the length of the first segment of your index finger, which approximates 2.5 cm.
• Using the insulation mixture, build 3 saucepan supports of 2.5 cm high each, inside the bigger saucepan seat and 2 supports in the smaller one.
• The supports in the bigger seat should be equidistant from the centre of the combustion chamber with a uniform angular spacing of 120.

7.6 Finishing the stove construction

Note:
• For the rocket lorena stove only 2 saucepan supports are fixed in the smaller saucepan cavity to minimizing obstruction of fire (fuel gas).
• The saucepan ring offers additional support to stabilise the saucepan.
• Smooth out the ridges in the chimney tower to get a regular shaped chimney.
• Plaster the stove body to give it a good finish. You may use any of the materials that are used to plaster mud walled huts e.g. a mixture of sap from sweet potato vines, silt and water or a mixture of sand, cow dung and water, etc.
• Use wet fingers, wet trowel or layers of a cut banana stem to smooth the finish such that the stove is completely smooth without cracks.
• If available use the spirit level to inspect and ensure that the top surface of the stove is horizontal. The use of the spirit level is optional.
• Leave the stove block to dry for 4 weeks, while covered with a watertight material e.g. polythene sheet or banana leaves.
• Protect the stove from sunshine and restrict children and animals from accessing it during the drying process.
• Continue to insert the saucepan and rotate it back and forth to maintain the size of the saucepan cavities during the drying process. It is recommended that this should be done at least twice in a day i.e. in the morning and evening

After 4 weeks of drying:
• Smooth the fire (hot flue gases) passage including combustion chamber and air inlet using wet hands.

Note:
By this time the stove body may have cracked during the drying process, seal the cracks using the original form of mixture that was used in stove construction.

Efficient cooking practices
• Always use dry firewood split into small pieces. Wet firewood loses its heat value in driving off excess water. It also produces a lot of smoke.
• Always use a saucepan lid to cover food when cooking. This creates cooking pressure leading to faster cooking and saving fuel.
• Cut food into smaller pieces. The technique reduces the amount of energy required to cook.
• Soak the dry preserved food Beans Peas for at least 5 hours before cooking them. This cuts down the energy to cook such foods.
• Light the fire after preparing the food for cooking.